Assessment of residuum volume and shape following lower limb amputation: validity and reliability of a novel structured light 3D scanner

James Bilzon PhD[a], Elena Seminati, PhD[a], David Canepa Talamas, MSc[b], Matthew Young, MSc[c], Martin Twiste, PhD[d,e], Vimal Dhokia, PhD[b],.

[a] Department for Health, University of Bath, Bath, UK. [b] Department of Mechanical Engineering, University of Bath, Bath, UK. [c] Department of Computer Science, CAMERA Centre, University of Bath, Bath, UK. [d] School of Health Sciences, University of Salford, Salford, UK. [e] United National Institute for Prosthetics & Orthotics Development (UNIPOD), University of Salford, Salford, UK.

Objective assessment methods to monitor residuum volume following lower limb amputation are required to inform treatment decisions with regard to timing and design of prosthetic sockets. The recent Artec Eva 3D scanner (Artec, Luxembourg), based on laser free technology, could potentially be a more effective solution compared to current clinical practice.

This study aimed to assess the validity and reliability of the Artec scanner in measuring transtibial and transfemoral residuum model volumes and shapes.

Three operators scanned ten residuum models on three separate occasions, using the Artec Eva and the high precision Romer laser scanner (Romer - Hexagon, UK). Models were manually aligned using anatomical reference points (Artec Studio software). Bland-Altman and Hopkins statistics were adopted to evaluate validity and reliability of the Artec scanner.

Volume validity mean percentage error was 1.4% of the actual volumes (range 885 - 4399 ml). Intra-rater and inter-rater reliability coefficients (13.9 and 18.5 ml respectively) were lower compared with current clinical practice values (42 ml). Shape percentage maximal error was 2% (at the residuum proximal end), with intra-reliability coefficients presenting the lowest errors (0.2%).

These results demonstrate that the Artec scanner is a promising alternative for assessing residuum volume and shape changes in lower limb amputees.